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ALTERNATING DEPOSITION OF PYRITE, MARCASITE AND POSSIBLY MELNIKOVITE

W. A. TARR, *University of Missouri.*

INTRODUCTION

Numerous small deposits of pyrite or marcasite or both occur throughout central Missouri. They are especially common at the contact of the Mississippian and Pennsylvanian (where a marked unconformity exists), but are found also in sinkholes and along fault planes in the Ozarks and to the east of the St. Francis mountains in southeastern Missouri. Some deposits are of sufficient size to be worked on a small scale.

The material upon which the following notes are based was secured from a deposit about three miles southeast of Fredricktown, Madison county, Mo., in the southeastern part of the state. The deposit occurs in the Bonneterre dolomite (Cambrian) and is evidently associated with a fault, though definite evidence of this is lacking. There are many prospect holes and pits in the vicinity, some of which were opened more than twenty years ago when a small amount of pyrite was mined and shipped. The Bonneterre dolomite is probably thin for it rests upon rhyolite porphyry some 200 yards to the southwest, and the same porphyry outcrops 400–500 yards to the east.

Both marcasite and pyrite occur in the deposit, the former predominating quantitatively. The major part of the marcasite consists of radiating, plumose, and stalactitic aggregates. The sides and ends of all these forms are covered with crystals, some of which are 5 mm. across. Radiating rods of spear-head twins are quite common. Essentially all the crystal forms are either spear-head twins or coxcomb twins, the former showing a tendency to develop a pseudo-pyramidal form.

The pyrite consists of similar radiating and stalactitic aggregates, likewise terminating in crystal faces. The dominant form is the octahedron modified by the cube, but there are also a few cubes modified by octahedrons. An octahedron with the solid angles truncated by a striated face was observed on a few specimens.

The interesting feature of this material is the occurrence of the pyrite and marcasite in alternating layers, varying from 1 mm. to 5 mm. in width. The layers are fibrous and radiating and often are terminated by crystal faces. Usually these layers are separated by a thin band of a black powder-like material. This is a sulphide, and probably was originally melnikovite, the amorphous black iron disulphide. The black mineral occurs between successive layers of pyrite about as frequently as between the pyrite and marcasite. It occurs very rarely between two layers of marcasite.

The last band or layer to be deposited, usually marcasite, may have a thickness up to several centimeters and is terminated with crystal faces. Any succeeding layer is not crystallographically similar, even though the mineral is the same. The pyrite layers frequently start with a very thin, dense band which soon becomes distinctly fibrous. This layer may form the inner wall of the stalactitic forms or the first layer after the black powder was deposited. The change from pyrite to the black powder or to marcasite was evidently rapid as crystal faces, if present on a layer, are very minute.

The black powder has tentatively been called melnikovite. It would be more correct to say it probably represents an original deposit of melnikovite, because the material, although a soft black powder, is not now magnetic. A careful study with a microscope revealed the presence of minute grains of pyrite all through the black powder, which in all probability is now extremely finely divided pyrite, as the amorphous melnikovite passes over into the crystalline pyrite in time. The change from pyrite to marcasite, or vice versa, was not dependent upon the presence of the black powder but took place independently. As will be shown below, the formation of the black band represents a rather special condition of the depositing solution.

There are many deposits of pyrite and marcasite in central Missouri in which either mineral may be deposited upon the other, but this is the only one where the writer has found them in alternating layers. The deposits we are discussing are of interest in showing how the character of the solutions may have varied sufficiently during the formation of a single deposit to permit the deposition of any one of three different forms of a polymorphous substance as a layer on either of the other two.

CONDITIONS OF DEPOSITION

Some years ago, Stokes,[1] and then later, Allen, Crenshaw and Johnston,[2] investigated fully the conditions that control the formation of pyrite and marcasite. They found that they could be formed in the same deposit, never simultaneously, but always under slightly different conditions. There were two controlling factors, (1) the character of the solution, and (2) its temperature. Of these the major factor is the character of the solution, marcasite requiring an acid and pyrite a neutral or slightly acid solution.[3] A complete change to an alkaline solution favors the deposition of the amorphous black disulphide, melnikovite.

The temperature of the solution, although important, is not as fundamental as the first. Pyrite certainly may be deposited from cold solutions, as is shown by its widespread occurrence in sedimentary rocks, and appears to be formed even better at temperatures well above 100°, as is indicated by its extremely common occurrence in high temperature deposits of all types. The conditions favoring the deposition of marcasite are very narrow as compared to those for pyrite. As shown by Allen, Crenshaw and Johnston, the optimum conditions for marcasite are 1.18% free H_2SO_4 at 100°. Decrease of acidity reduces its formation, and change of temperature in either direction does likewise. Decreasing the acidity to neutrality and raising the temperature favors the deposition of pyrite. Melnikovite evidently forms best at temperatures below 100° as is shown by its formation in the muds on the bottom of the Black Sea and probably on the ocean floor. It may form, however, at 100°C in alkaline solutions.

Pyrite may form in a slightly acid solution and therefore might be formed under conditions favorable for marcasite formation, so that the two might be deposited almost simultaneously, but with the pyrite greatly in excess.

The material studied shows no evidence of simultaneous deposition, but does show distinctive alternating periods of deposition of marcasite and pyrite, with a third member in the series appearing from time to time. Initial deposition in the material collected for study took place for the most part with marcasite, but in some instances pyrite was first. As the material was collected from dumps, the contact with the wall was not seen, hence it is not definitely known which was absolutely deposited first.

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[1] Stokes, H. N. "On Pyrite and Marcasite," *U. S. G. S. Bull.* **186** (1901).

[2] Allen, Crenshaw and Johnston. "The Mineral Sulphides of Iron." *Am. Jour. Sci.* (4) **33** 169–236 (1912).

[3] An editorial in the *Min. & Sci. Press*, vol. **107**, p. 446 (1913), makes the statement that pyrite has been formed under surface conditions in an acid solution.

As the major part of the deposit is marcasite, it is evident that the temperature of the solution during deposition was near 100°C. The temperature may have exceeded or been less than this during the mineralization, but, in any case, the solution was fairly hot at all times.

Solutions having a temperature of 100° are certainly rising solutions, whether their source be meteoric or magmatic. As they passed through the Bonneterre dolomite in the last stages of their upward journey, unless their initial acidity was very high, they should have become neutralized to a certain degree. If neutralization took place, pyrite would be formed; whereas if the solution retained more or less free acid, marcasite would be deposited.

Assuming that marcasite was formed first from an acid solution, the acidity might be slowly reduced by the dolomite until conditions were favorable for the formation of pyrite. Its deposition would then continue until the character of the solution was changed again. If, after being reduced to neutrality, the solution was made alkaline in its passage through the dolomite (and probably accompanied by a downward temperature change) the amorphous black powder (melnikovite) would be deposited. The reverse change to neutrality would mean a layer of pyrite, or, a rapid change (by increased supplies from below) to marked acidity would cause marcasite to form; all these changes being possible at around 100°.

The fact that the black bands are more commonly interlayered with pyrite shows that the changes were probably brought about slowly, although there were times when the change was very rapid. The rare occurrences of black bands in the marcasite represent one of these rapid fluctuations from acidity to alkalinity and back again. The occasional wide bands of the black material with the pyrite, often as wide as the adjacent layers, indicate that the alkaline conditions lasted for some time.

Thus the successive layers and other alternating forms can readily be accounted for by change in the chemical character of the depositing solution, for all might be deposited at the same temperature, or at least within a few degrees of each other. The material studied apparently gives striking support to the experimental work of the authors cited above, provided, of course, that the interpretation of the black powder as being originally melnikovite is correct.

The writer inclines to the view that the solutions are of magmatic origin. The cobalt-nickel-copper deposits of Fredricktown and Mine La Motte are only a few miles away. The former, which are within a mile of this deposit, contain enormous quantities of marcasite along with the other sulphides, and this deposit may well be connected with them in origin. In fact, this deposit has a structural position in the dolomite adjacent to two outcrops of igneous rocks, which are pre-Cambrian, that resembles to a marked degree the mode of occurrence at Fredricktown. It may be added that pyrite is abundant in the granites and granite-porphyries of the St. Francis mountains to the west.

As far as could be determined from the literature, this is the first instance where the amorphous iron disulphide may have been deposited by hot solutions along with the other polymorphous forms of the iron disulphide, and this gives added interest to the deposit.

ADDITIONAL DATA ON THE PROPERTIES OF PUMPELLYITE, AND ITS OCCURRENCE IN THE REPUBLIC OF HAITI, WEST INDIES[1]

W. S. Burbank, *U. S. Geological Survey.*

In 1921 during a geological reconnaissance in the Republic of Haiti, undertaken by the Haitian government in cooperation with the United States Geological Survey,[2] Dr. J. S. Brown and the writer collected a cobble of a peculiar amygdaloidal basalt from the bed of the Limbé River at Limbé in northern Haiti; the basalt was not greatly unlike many of the older basaltic rocks of this region, but the amygdules were very noticeable and abundant, most of them being lined with white albite and the central part filled with greenish-yellow iron rich epidote and a deep bluish-green mineral which did not agree with any described species, but was considered from its crystal properties as probably belonging to the epidote group.[3]

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[1] Published by permission of the Director of the U. S. Geological Survey.

[2] Woodring, W. P., Brown, J. S., Burbank, W. S.; Geology of the Republic of Haiti: Dept. of Public Works, Rep. of Haiti, Port-au-Prince, 1924.

It was the intention to separate this mineral and have a chemical analysis made but this work was delayed, and in 1924 when at Calumet, Michigan, the writer discovered while examining thin sections of the Keweenawan amygdaloids that the mineral from Haiti was apparently identical with the "green zoisite" of the copper deposits. This "green zoisite," subsequently given the name pumpellyite[4] by Palache and Vassar, was then under investigation in connection with studies carried on by the Calumet and Hecla Consolidated Copper Company.

Since that time the writer has had the opportunity to recheck his original determinations of the optical properties of the mineral from Haiti and compare them with those published for pumpellyite. The mineral was found to differ in optical orientation, and somewhat in indices and birefringence compared with the data given for pumpellyite. The mineral from Haiti while occurring in smaller quantity than pumpellyite in Michigan, is better crystallized and more satisfactory for optical study.

The bluish green mineral was determined to have the following optical properties:

Optically positive. 2V large, estimated 75° to 80°. Dispersion strong, $\rho<\nu \cdot \alpha=1.700$; $\beta=1.707+$; $\gamma=1.718\pm$[5]. The α and γ vibration directions are practically colorless; the β direction is bluish green. Crystal development is prismatic parallel to Y (=crystal axis *b*?). Vibration direction γ makes an angle of about 31° with a cleavage presumably basal (001).

On the basis of the above optical properties, the mineral is probably monoclinic with prismatic development parallel to the *b* axis and an orientation practically identical with that of epidote. The basal cleavage is well developed and in sections parallel to the axial plane, which are colorless and non-pleochroic, measurements of the angle $\gamma \wedge (001)$, gave values around 30° to 32°. The birefringence of these sections was estimated to be about .020. Sections parallel to Y ($=b$?) are distinctly fibrous in appearance and the interference colors show evidence of the strong dispersion.

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[3] Geology of the Republic of Haiti, Igneous Rocks, page 271.

[4] Palache, Charles, and Vassar, Helen E.; Some minerals of the Keweenawan copper deposits: Pumpellyite, a new mineral; sericite; saponite. *Am. Mineral.* vol. **10**, No. 11, pp. 412–418, Nov., 1925.

[5] Values for indices of refraction are ± .003.

The amygdaloidal basalt in which the mineral occurs is of a purplish brown color with abundant amygdules ranging from less than a millimeter to 4 or 5 mm. in diameter. The texture as revealed in thin section is intergranular and typical of basaltic rocks, with the plagioclase laths .05 to .10 mm. in length, and the interstitial areas occupied by granules of augite of about .05 mm. in size. The plagioclase of the original unaltered basalt has been recrystallized without destroying the texture or orientation and is now largely albite. The augite remains practically colorless and unaltered. Magnetite appears to have been partly recrystallized, and platy hematite, probably secondary, is common.

Many of the amygdules are lined with albite crystals, or the crystals may project into the amygdule, while the central part is occupied by a network of fibers and small prisms of pumpellyite. The largest prisms of pumpellyite seen are about 0.2 mm. in length and .05 mm. in cross-section. The pleochroic yellow epidote when present in the amygdule occurs at the very central part in radiating prismatic groups, and is clearly later than pumpellyite.

Veining the rock are a few veinlets a millimeter or less in width, consisting of albite and a little quartz.

The order of formation of the secondary minerals is albite, chlorite, pumpellyite, and finally epidote.

The basalt is presumably of the same age as many similar basaltic rocks of the northern range of Haiti. The exact age of these rocks is unknown but they are definitely pre-Upper Cretaceous and for certain reasons are considered most likely of middle Mesozoic age.[6]

The type of alteration described above is typical of certain stages of a widespread metamorphism in the volcanic rocks of the northern range,[7] and has probably been produced by a batholithic intrusion of quartz diorite of late Cretaceous age. In an intense development of the metamorphism the conversion of the basic plagioclase to an albite is invariably accompanied by the separation of epidote or clinozoisite, and often with the development of some sericite, while the pyroxene is converted partially or completely to uralitic hornblende. Where the intensity of the metamorphism is less the augite is often uneffected as in the specimen described above. Still weaker phases are represented by the formation of prehnite and zeolites from the alteration of the feldspars, either as replacement of the feldspars or filling cracks and cavities in altered rocks.

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[6] Geology of the Republic of Haiti, Igneous Rocks, pp. 267, 268.

[7] *Op. cit.* p. 272.

The specimen containing the pumpellyite is possibly a unique variety of the intermediate phase of alteration in that no other occurrence of this mineral was found; nor was the particular amygdaloidal basalt containing this mineral found as a bedrock outcrop. It is possible however that a search in the vicinity of the upper part of the Limbé River would reveal outcrops of this rock, as the region was not explored during the reconnaissance.

AMMONIOJAROSITE, A NEW MINERAL OF THE JAROSITE GROUP FROM UTAH

EARL V. SHANNON,[1] *U. S. National Museum.*

One of the most illustrative cases of isomorphism in systematic mineralogy is furnished by the jarosite division of the alunite-beudantite group. The original jarosite, known since 1838, is a hydrous sulphate of ferric iron and potassium. Sixty-four years later Hillebrand and Penfield described two new jarosites in one of which the potassium was replaced by sodium while the other contained, in place of the alkali metal, lead. The latter mineral has been found in a number of places since and in some localities is an important constituent of ores. Still more recently Schaller has called attention to a very interesting member of the group in which silver enters as an essential constituent. The purpose of the present short paper is to describe briefly a fifth jarosite in which the essential alkali is ammonium oxide. The present members of the jarosite group are as follows:

Jarosite	$K_2O \cdot 3Fe_2O_3 \cdot 4SO_3 \cdot 6H_2O$.
Natrojarosite	$Na_2O \cdot 3Fe_2O_3 \cdot 4SO_3 \cdot 6H_2O$.
Plumbojarosite	$PbO \cdot 3Fe_2O_3 \cdot 4SO_3 \cdot 6H_2O$.
Argentojarosite	$Ag_2O \cdot 3Fe_2O_3 \cdot 4SO_3 \cdot 6H_2O$.
Ammoniojarosite	$(NH_4)_2O \cdot 3Fe_2O_3 \cdot 4SO_3 \cdot 6H_2O$.

The ammoniojarosite is from southern Utah. This is interesting, geographically, since all known members of the group have been

[1] Published by permission of the Acting Secretary of the Smithsonian Institution.

found in this state. The new member was found in a shipment of minerals sent to the National Museum for identification by Mr. Frank Haycock of Panguitch, Utah. This shipment consisted principally of tschermigite, or ammonia alum, associated with a little of the jarosite in a black lignitic shale. In response to a request for more material Mr. Haycock forwarded additional specimens of the jarosite and tschermigite together with some associated minerals which included epsomite, palygorskite, and celestite as well as bentonitic material and a few imperfect fossils. All of these minerals will be described in detail in a paper which is being prepared for publication in the Proceedings of the U. S. National Museum.

The locality is not given more definitely than on the west side of the Kaibab fault in southern Utah. In the hand specimen the material is indistinguishable from the associated tschermigite and jarosite from Wamsutter, Wyoming, described by Erickson.[2] The two localities are, however, some 300 miles apart.

The ammoniojarosite forms small lumps and hard irregular flattened nodules up to 4 centimeters broad by 5 millimeters thick embedded in blackish-brown lignitic material. They frequently enclose small grains of the lignite and fibrous patches of tschermigite. On a fresh fracture the color is a light ocherous yellow while the lustre varies from dull and waxy to earthy.

One of the largest and purest lumps was selected and freed as far as possible from adhering lignite. This was ground finely and digested with frequent stirring in hot distilled water to remove all water soluble tschermigite and other salts. It was then filtered, washed thoroughly with hot water, dried in air, reground and allowed to stabilize its water content in air for several days. It was then analyzed by standard methods. Five grams were weighed out, dissolved in hot dilute hydrochloric acid and filtered. The insoluble material was dried for several days in air and then weighed after which it was ignited and weighed again. It consisted principally of lignite with some clayey material. This solution was diluted to 500 cc. and divided into 5 aliquot parts, each equivalent to a 1.0 gram sample. On these portions iron, alumina, lime, magnesia, soda, potash, and sulphuric acid were determined. Separate portions of the same sample were used for the direct determination of $(NH_4)_2O$ and water. The analysis gave the following results and ratios:

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[2] E. Theodore Erickson. Tschermigite (Ammonia alum) from Wyoming. *Jour. Wash Acad. Sci.*, vol. 12, pp. 49–54, Feb. 4, 1922.

Analysis and Ratios of Ammoniojarosite from Utah.
(Earl V. Shannon, analyst.)

Constituents	Per cent	Ratios		
Insoluble	0.76			
TiO_2	trace			
Al_2O_3	0.02	.000	.309	.103×3
Fe_2O_3	49.30	.309		
CaO	0.05	.001	.106	.106×1
MgO	0.13	.003		
Na_2O	0.22	.004		
K_2O	1.56	.017		
$(NH_4)_2O$	4.23	.081		
PbO	trace			
Ag_2O	none			
SO_3	34.49	.431		.108×4
H_2O	9.86	.547		.091×6
	100.62			

The above results agree very well with the formula: $(NH_4)_2O \cdot 3Fe_2O_3 \cdot 4SO_3 \cdot 6H_2O$. The existence of the ammonia member of the group is thus established. The theoretical composition to satisfy the above formula is: $(NH_4)_2O$ 5.43 per cent; Fe_2O_3 49.92; SO_3 33.38; and H_2O 11.27.

Under the microscope the analyzed sample was found to be composed of minute, transparent, pale-yellow, tabular grains a few of which showed hexagonal outlines. These were too small to yield an interference figures but those lying on the flat side are dark between crossed nicols so that the mineral is probably nearly uniaxial. Plates on edge show positive elongation so the mineral is perhaps optically negative. The refractive indices could not be measured exactly but they are approximately: $\omega = 1.800$, $\epsilon = 1.750$, both ± 0.005.

NOTES ON THE MINERAL LOCALITIES OF RHODE ISLAND

PART II. REMAINING COUNTIES

Lloyd W. Fisher and Charles G. Doll, *Brown University.*

Minerals Not Included Under Providence County[1]

- Almandite
- Apatite
- Asbestus
- Autunite
- Chabazite
- Chlorite
- Epidote
- Fluorite
- Labradorite
- Lignite
- Magnetite sand
- Masonite
- Monazite
- Oligoclase
- Olivine
- Prochlorite
- Phlogopite
- Pyroxene
- Quartz
  - Amethystine
  - Asbestiform
  - Carnelian
  - Flint
  - Jasper
- Scapolite
- Sillimanite
- Staurolite
- Stilbite
- Zoisite

BRISTOL COUNTY

The major portion of Bristol County shows sedimentary rocks consisting chiefly of the Rhode Island formation of shales, conglomerates and sandstones. B. K. Emerson[2] has mapped the peninsular portion of Bristol Neck as granodiorite. The low cliffs bordering the Taunton River are made up of a coarse grained to porphyritic pink orthoclase granite cut by numerous quartz stringers and pegmatitic granite. The low cliffs of the Mt. Hope Bay region are mainly agatized quartz similar to the Diamond Hill area of Providence County.

The Bristol area, in the vicinity of Portsmouth Ferry, was famed years ago for the beautiful specimens of amethystine quartz which were found about 1835.

Bristol

Locality	Minerals Found	Remarks
Bristol Highlands	Limonite	After pyrite
	Melanterite	White; encrusting shale.
	Pyrite	Crystals as large as 1 cm.

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[1] L. W. Fisher and E. K. Gedney: Notes on the Mineral Localities of Rhode Island. *Am. Mineral.*, **11**, No. 12, pp. 334–340, (1926.)

[2] B. K. Emerson: Geology of Massachusetts and Rhode Island. *U. S. G. S Bull.* **597**. See map.

See also A. C. Hawkins, and C. W. Brown: Basic Rocks of Rhode Island. Their correlation and relationship. *Bull. Geol. Soc. Amer.*, **26**, pp. 92–93.

Locality	Minerals Found	Remarks
Bristol Ferry	Epidote	Along quartz veins.
N. of light	Hornblende	½ in. crystals in quartz.
	Muscovite	Large plates in pegmatite.
	Orthoclase	Pink; white; in dikes.
	Quartz	Massive; milky; in veins.
	Rutile	As needles in quartz.
E. of light	Same as above and	
	Chlorite	Pseudomorphous after biotite.
	Ilmenite	In plates in pegmatite.
	Magnetite sand	Along strand line.
	Phlogopite	In 2 in. orthoclase dike.
	Quartz[3]	Amethystine variety.
Mt. Hope Bay area	Agate	In definite, parallel bands; some 2 in. wide; reds and greens predominate.
	Hematite	Thin plates.
	Quartz	Massive, in druses.

KENT COUNTY

Fringes of sedimentary rocks are found in the east section of this county in contact with a crystalline background which is quite metamorphosed to the west. Minerals are most abundant in the latter areas. The authors have deemed it advisable to include the northern portion of Moosup Valley, which runs northward into Providence County, in this discussion. The rocks of this extreme western area are chiefly Moosup Valley gabbro, Northbridge and Putnam gneisses, quartz stringers, granite pegmatites, granites and various schists.

Town of Coventry

Locality	Minerals Found	Remarks
Moosup Valley area	Chlorite	In large plates
Bennett Hill[4] 2 mi. S. W.	Epidote	Fair sized crystals, near contact with quartz and schist.

[3] The best locality for amethystine quartz located by the writers is about 100 yards east of the ferry near a spring. It is found in a disintegrating granite. Some excellent blue crystals, four to six inches in length, are in the Museum of the Department of Geology. These were shown at the Centennial in Philadelphia in 1876 by the Providence Franklin Society.

[4] This is the old South Foster Gold mine locality which is said to have produced gold, chiefly from pyritiferous-quartz veins. Four open pits filled with water were visible at the time of the study. The foundations of a rather large stamp mill still stand.

Locality	Minerals Found	Remarks
	Hornblende	Three in. long.
	Orthoclase	Large pink crystals.
	Pyrite	Large veins, 4 to 6 in. in width in quartz.
	Pyrrhotite	With pyrite.
Between S. Foster and above.	Actinolite	In schist.
	Apatite	Euhedral crystals.
	Biotite	Some 8 in. plates.
	Epidote	Near contacts.
	Garnet	Near contacts.
	Magnetite	Octahedral crystals in pegmatite.
	Scapolite	Large crystals in the scapolite-biotite gneiss.
Along Moosup River N. from highway	Chlorite	In schist with olivine.
	Cyanite[5]	In schist.
	Ilmenite	Platy, lamellar.
	Labradorite	Large phenocrysts in gabbro.
	Microcline[5]	In drift boulders.
	Olivine	Large grains in fresh gabbro.
	Serpentine	From the olivine.
6 mi. S. W. of Clayville	Chlorite	Platy on quartz crystals.
	Quartz	Massive; milky; smoky; doubly terminated.
	Tourmaline	In quartz veins.
N. of W. Greenwich	Magnetite	Octahedral crystals.

EAST GREENWICH

In the northwestern portion of the town there are some excellent exposures of the granite porphyry of the East Greenwich group.[6] The best mineral localities are in this porphyry and are described under Warwick.

Locality	Minerals Found	Remarks
Bald Hill	Biotite	In the porphyry.
East slope	Magnetite	Where micrgranite cuts dark colored granite.
	Microcline	In blue-quartz porphyry.
	Orthoclase	In blue-quartz porphyry and granite porphyry.

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[5] Not found by the writers but reported from specimens in the departmental museum. Specimens collected by C. W. Brown and others.

[6] B. K. Emerson and J. H. Perry: Green schists and associated granites and porphyries of Rhode Island. *U. S. G. S. Bull.* **311,** p. 58 (1907).

LOCALITY	MINERALS FOUND	REMARKS
	Quartz	Blue; in the blue quartz porphyry.
Bellefont[7]	Agate	In quartz veins.
	Hematite	Small plates.
	Graphite	In shales.
Drum Rock Hill W. of Apponaug	Epidote	In quartz veins.
	Garnet	In conglomerate.
	Hematite	In quartz veins.
	Ottrelite	In conglomerate.
Gaspe Point	Magnetite sand	With small garnets; strand line.
Norwood	Pyrite	Large xls. in shale.
Natick	Chlorite Epidote Garnet Magnetite	These minerals occur in or near the contact of quartzite, conglomerate and arkose. They are also found interstitially on high bluff west of village.
	Ilmenite	In pegmatite cutting quartzite.
	Orthoclase	In pegmatite.
	Masonite[8]	
Pawtuxet[7]	Quartz	Jasper and carnelian in shales.
Potowomut Neck	Graphite	In shales.
(S. side of Greenwich cove)	Quartz	Asbestiform; milky; and ferruginous.
Spencer Hill (S. and W. slope)	Magnetite	Probably secondary, penetrating microcline.
	Quartz	In granite porphyry.
1. mi. southwest	Augite	In diabasic dike.
	Garnet	Almandite in conglomerate.
	Labradorite	In fair sized xls., in diabasic dike.
	Quartz	Bordering biotite in diabasic dike.
Warwick Neck	Augite	Crystals in drift.
	Graphite	In shales.
	Jasper	In shales.
	Limonite	Secondary after pyrite.

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[7] These towns are just north of the Pawtuxet River which divides Kent and Providence Counties.

[8] The mineral could not be found in place although boulders with plates of the chloritoid mineral were found. The old locality has been built over. See Charles Jackson; Report on the Geological and Agricultural Survey of Rhode Island, **1840**; and The Geology of Rhode Island; Providence Franklin Society, **1887**, p. 91.

NEWPORT COUNTY

The geology of this county is quite varied since both igneous rocks and sediments occur. The eastern portion of the county shows chiefly sedimentary rocks with some metamorphics near the northern border. Along the coast line from Tunipus Beach to Sakonnet Point igneous rocks predominate, chiefly a porphyritic granite. Wave action has leached out most of the femic minerals leaving large pits in the rocks.

LITTLE COMPTON

LOCALITY	MINERALS FOUND	REMARKS
Warren's Point a type locality	Epidote	Well developed xls. along aplite dike.
	Hornblende	Along aplite dike.
	Ilmenite	In plates in aplite which cuts granite.
	Orthoclase	Large pink xls. in granite.
	Quartz	Smoky; milky; in aplite.
Sakonnet Point	Apatite	Euhedral xls. in minette.
Tunipus Beach	Chlorite	Plates on quartz.

TIVERTON

Near Four Corners	Pyrite	In greenish slate.
	Quartz	Veins cutting limestone.
Along Sin and Flesh brook	Actinolite	Large needles in hornblende-biotite schist.

MIDDLETOWN

Easton's Beach	Actinolite	In needles in quartz veins which penetrate conglomerate and sandstone.
	Limonite	In argillaceous mica schist, after pyrite.
	Hornblende	Same as actinolite.
	Magnetite	Same as limonite.
	Rutile	Same as actinolite.
Paradise (Hanging Rock)	Chlorite	Same as actinolite.
	Magnetite	
	Mica	Chiefly biotite.
	Orthoclase	In porphyritic granite.
	Zoisite	In thin veinlets.
Purgatory	Garnet	In conglomerate.
	Magnetite	In conglomerate.

LOCALITY	MINERALS FOUND	REMARKS
Sachuest Neck and Point (E. shore)	Augite	In talc schist.
	Garnet	In conglomerate.
	Hematite	" "
	Magnetite	" "
	Quartz	" "
	Talc	In talcose schist.
	NEWPORT	
Bailey's Beach	Feldspars	Large xls. in granite.
Bishop Rock	Garnet	Euhedral xls. in conglomerate.
Brenton's Cove Fort Adams, E. side	Calcite	Xls. in argillaceous mica schist.
	Quartz	In mica schist, iron stained.
	Serpentine	In mica schist.
	Chlorite	These minerals occur in a coarsely porphyritic granite.
	Magnetite	
	Oligoclase	
	Orthoclase	
	Titanite	
	Zoisite	
Miantonomah Hill (S. side of Coddington Cove)	Chlorite	Large plates in quartz veins in conglomerate.
Ochre Point	Calcite	In shales.
	Serpentine	Serpentinous shales.
	Epidote	Transition product in epidote-chlorite schist.
	Talc	In epidote-chlorite schist.
	Ottrelite	" " " "
	PORTSMOUTH[9]	
Near old coal mine, west shore.	Calcite	In shales.
	Chalcopyrite	" "
	Garnet	Near contacts with schist.
	Graphite	In shales. Graphitic anthracite.
	Ottrelite[10]	In metamorphosed shale.
	Quartz	Fibrous, in veins.
	Prochlorite	In schist.
	Staurolite	In schist.
	Siderite	In quartz veins cutting graphitic shales.

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[9] For general geology see Geology of Aquidneck Island. N. S. Shaler. *Amer. Nat.*, Vol. 6. 1872.

[10] Specimens labeled Newportite in the Roger Williams Park Museum, Providence, are probably identical with ottrelite. Newportite is mentioned by S. B. Robinson in Catalogue of American Mineral Localities, 1832; by Horace F. Carpenter, Mineral Catalogue of New England Localities, 1860.

NEW SHOREHAM
(Block Island)

Locality	Minerals Found	Remarks
South shore	Almandite	In pegmatite.
	Beryl[5]	" "
	Clay iron stone	Concretionary in shale.
	Magnetite	With garnet sands.
	Limonite	In shales.
	Kaolin	In low bluffs.
	Pyrite	With the above.
	Monazite[11]	In sands.
	Sillimanite	
	Zircon	

JAMESTOWN[12]

The island of Conanicut on which Jamestown is located is made up chiefly of a rather fissile, greenish shale accompanied in the southern portion by altered shales and granites. Both types are cut by basic dikes.

Locality	Minerals Found	Remarks
Hull's Cove	Apatite	In euhedral xls. in minette dike. Same as at Sakonnet Point.
	Biotite	In minette dike, n. and s. end of island.
	Titanite	In minette dike.
	Zircon	" " "
Mackerel Cove (W. side of cove)	Siderite	Numerous xls. in hornfels.
Potter's Point	Albite	In phyllitic shale.
	Graphite	" " "
	Hematite	" " "
	Muscovite	" " "
	Tourmaline	Fair sized euhedral xls.
South shore	Calcite	
	Chlorite	From biotite.
	Oligoclase	South shore, eastern portion of Island.
	Orthoclase	From eastern part of Island
	Magnetite	" " " "
	Quartz	" " " "
	Sericite	Platy on feldspars.
	Titanite	Euhedral xls. in feldspars.

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[11] From specimens in R. W. Park Museum donated by A. P. Watt.

[12] For Geology see L. V. Pirsson, Geology of Conanicut Island. *Amer. Jour. Sci.*, 3rd Ser., Vol. **XLVI**, pp. 363–378.

Locality	Minerals Found	Remarks
West shore midway between north and south ends of the island.	Epidote	In altered shales.
	Garnet	“ “ “
	Ottrelite	“ “ “
	Staurolite	“ “ “

WASHINGTON COUNTY[13]

This county is quite important geologically because of the famous Westerly granite quarries which are worked extensively in the towns of Westerly and Bradford (formerly Niantic). The Westerly granite cuts the Sterling granite gneiss and is in places cut by an olivine diabase dike which is well shown in the Smith quarry, Westerly, and at White Rock 4 miles north of Westerly. The general geology and mineral localities of all districts are somewhat similar. Locally there are pegmatitic phases of the Westerly and these are the best mineral repositories. A few of the prominent localities will be described.

Charlestown

Locality	Minerals Found	Remarks
Kenyons	Sillimanite	In schist; locally distributed.
Quonochontaug	Biotite	In large plates in an orbicular granite.

Hopkinton

Locality	Minerals Found	Remarks
½ mi. N. of town on Nooseneck Hill road	Biotite	In Sterling granite-gneiss.
	Chlorite	
	Ilmenite	
	Orthoclase	
	Quartz	

North Kingstown

Locality	Minerals Found	Remarks
Hamilton	Calcite	Perfect xls. in sandstone.

South Kingstown

Locality	Minerals Found	Remarks
Wakefield	Ilmenite	Large plates in pegmatitic phase of Westerly.
Watch Hill to Point Judith	Magnetite	With garnet in sand.
Usquepaug	Molybdenite	In pegmatitic granite.

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[13] E. K. Gedney, joint-author of Providence county localities, assisted in this area.

NARRAGANSETT

LOCALITY	MINERALS FOUND	REMARKS
Tower Hill	Autunite[14]	In pegmatitic phase.
	Orthoclase	In pegmatitic phase, large crystals.

WESTERLY

LOCALITY	MINERALS FOUND	REMARKS
Smith Quarry, S. E. of Westerly, also in Smalley Quarry, N. of Westerly	Allanite[15]	In granite unless otherwise noted.
	Apatite	
	Beryl	
	Biotite	
	Calcite	Along contact of the olivine diabase dike and granite.
	Chabazite	Along contact of olivine diabase.
	Natrolite	
	Stilbite	In fractures.
	Cyanite	
	Epidote	
	Fluorite	On fracture planes: purple cubes.
	Ilmenite	
	Molybdenite	
	Microcline	
	Muscovite	
	Pyrite	
	Oligoclase	

The largest feldspar crystals, simple, or twinned according to the Carlsbad law are found in the coarse phase of the Westerly granite in the Sullivan quarry, Bradford. In most cases noted the domatic faces of the crystal, which may be a foot or more in size, are coated with biotite which is being chloritized. Smoky and transparent quartz crystals are found in abundance in the same locality and these reach a size of 4 inches. The Sullivan quarry is an ideal mineral collecting ground.

OTHER AREAS OF MINOR IMPORTANCE

The writers have visited all the important or promising mineral localities of the State during the past field season and some regions of minor importance are included. Minerals from these areas are listed here with the finder's name, those not so listed were found by the senior author.

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[14] Found by C. W. Brown. Radio-activity determined by Gedney.

[15] See footnote 5.

Burrillville—Amethystine quartz and kaolin. (J. P. Beatty).
Chepachet—Magnetite in pegmatite. (A. C. Hawkins).
Albite—pericline in chlorite. (A. C. H.).
Centredale—Quartz crystals in green schist.[16]
Glocester (Durfee Hill)—Epidote, molybdenite, pyrite, pyrrhotite.[17]
Harmony (Steere Hill)—Ilmenite in pegmatite
Hughesdale—included under Johnston.

JOHNSTON

The general locality of this area is much the same as discussed under Ochee Springs and Violet Hill, Manton Avenue, Providence, in the first part (see footnote 1). Minerals found in Johnston outside these two localities, are: Actinolite, ankerite, calcite, chalcedony, chalcopyrite, pyrite, hornblende, tremolite, steatite, serpentine, and epidote. Magnetite in good crystals in chlorite Schist (A. S. Packard).

Lime Rock—Scolecite in calcite. (J. P. Beatty).
Pascoag—Epidote and tourmaline. (A. C. Hawkins).
Primrose (Premisy Hill)—Magnetite in arkose. (A. C. H.).
Richmond (Tunk Hill)—Actinolite in schist.
Snake Den—Chalcocite, epidote, fluorite (M. Bowe), garnet and malachite.

A gold-mine prospect was worked in this locality where a diabasic dike cuts the granites and schists. Cyanide vats and sluice boxes are still visible. A local chemist is authority for the statement that the locality is reported to have shown a trace of platinum in the debris.

Tarkiln—Quartz and magnetite in pegmatite.

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[16] A. C. Hawkins: Quartz crystals from Centredale, Rhode Island. *Am. Mineral.*, Vol. **3**., No. 1, pp. 1 and 2.

[17] This is also an old gold mine locality.

BOOK REVIEWS

PYROSOLE. DAS KOLLOIDE PHÄNOMEN IN DER GLÜHEND FLÜSSIGEN MATERIE UND SEINE ERSTARRUNGS-ZUSTÄNDE UNTER BERÜCKSICHTIGUNG DES LATENTEN PHOTOGRAPHISCHEN BILDES. (Pyrosols. Colloidal Phenomena in Molten and Solidified Matter with Consideration of the Photographic Latent Image.) RICHARD LORENZ, Ph. D., Professor and Director of the Institute for Physical Chemistry of the University, Frankfurt A. M., and WILHELM EITEL, Dr. phil. nat., Professor and Director of the Kaiser Wilhelm Institute für Silikatforschung, Berlin-Dahlem. Vol. 4, **Colloidal Investigations,** edited by R. Zsigmondy. Akademische Verlagsgesellschaft m. b. H., *Leipzig*, **1926.** IX+290 pp, 64 figs., 20 plates. 22 × 15 cm. Price, unbound, M. 18; bound, M. 20.

This book deals with an aspect of colloid chemistry with which the authors have been specially identified. The term "pyrosole" was coined by Lorenz to describe the colloidal phenomena in which molten metals and salts act as dispersing media. Eitel proposed the term "pyronephelite" to describe colloidal dispersions resulting from cooling a pyrosol, whether the dispersing medium be glassy or crystalline, and pyrosol and pyronephelite are used in the same contrasting sense as hydrosol and hydrogel in ordinary colloid chemistry. To the reviewer the argument for the adoption of the term pyronephelite seems not well founded; both Dana and Hintze are agreed that nephelite gets its name from the fact of its being cloudy when treated with acid, not from its containing inclusions of dispersed material derived from the magmatic solution, as stated on pp. 26-7. The greater portion of the book consists of an excellent summary of the work of Lorenz on the so-called subhalides, which are better regarded as colloidal solutions, analogous to the metallic clouds obtained by Lorenz by dispersing metals in their molten salts. The chapter on colored glasses is a good summary of the literature of this interesting subject, and the chapters on photonephelites (i. e., dispersions in solid media obtained by the action of light) and the photographic image give an excellent treatment of the silver nucleus theory of the photographic latent image. In the final chapter the dispersoids of the mineral world and of slags are treated. To the reviewer the persistent attempts of colloid enthusiasts to call the aqueous glasses obtained in the laboratory and in nature colloidal dispersions of water in glass, or, as put on p. 260, "Ihre Beschaffenheit ist diejenige eines hoch dispersen Emulsoides von flüssigen Wasser in amorph-Kolloidaler Glasmasse," seems unjustifiable in that such an interpretation is unnecessary, and adds nothing to the interpretation of such undercooled liquids. The rest of the discussion of minerals deals largely with dispersions obtained by unmixing, of which the unmixing of KCl-NaCl on cooling is an example which is discussed in detail. The concept is applied to the microperthites, which are interpreted as resulting from unmixing of a sodium-potassium feldspar mixed crystal and to aventurine feldspars. The discussion of slags could well be amplified, because in the unmixing of sulphides from silicate melts are obtained many examples of pyronephelite, as well as closely related cases in which the separated sulphides are collected in mass. The book as a whole is an interesting and well written account of a specialized branch of colloid chemistry.

GEORGE W. MOREY

TABELLEN ZUR ALLGEMEINEN UND SPEZIELLEN MINERALOGIE.

PAUL NIGGLI. XVI+300 pages, 228 figures. Bound in cloth, 9.30 M. Verlag von Gebrüder Borntraeger, *Berlin*. 1927.

In this book the author has brought together comprehensive tables for the determination of minerals based upon physical and optical properties as well as geometrical forms. The subject matter and figures have been taken largely from the numerous publications of the author. While it would be impossible in a short review to describe adequately the contents of this text, mention should be made of: (1) a general survey of the 32 crystal classes including the 14 space lattices and an atlas of the crystal forms in each system, (2) tables covering the uses and occurrences of the minerals of economic importance, (3) tables for the determination of gems and semi-precious minerals, and (4) the optical properties of the rock-forming minerals with tables for their determination.

These tables, no doubt, will serve as a convenient laboratory manual because of the fund of information contained and the ease with which the desired information can be found. W. F. H.

GEOLOGY MANUAL: AN INSTRUCTION AND LABORATORY MANUAL FOR BEGINNERS. PART 1, PHYSICAL GEOLOGY.

Richard M. Field, Ph. D. (Princeton University Press, *2nd Edition, 1927*).

As indicated in the preface, this Manual is the result of a pressing need of a laboratory instruction paralleling the introductory course in Geology. It is a wide field, and in the table of contents of this manual are eighteen heads, which have been chosen with great care as they cover the various fields of the subject. In the body of the book their weighed treatment reflects the same careful consideration.

In the field of mineralogy, the list of species studied is reasonable and well selected as after all the number of rock-forming and very important ore minerals is very small.

The text is clear, precise, and positively written, as it should be for a beginner. The Manual should fulfill the function for which it was written and be of great practical assistance in laboratory instruction. ALEXANDER H. PHILLIPS.

PROCEEDINGS OF SOCIETIES

PHILADELPHIA MINERALOGICAL SOCIETY

Academy of Natural Sciences of Philadelphia, Oct. 6, 1927.

The Philadelphia Mineralogical Society held its thirty-fifth anniversary meeting on the above date, the president, Mr. Vaux, presiding. Thirty-three members and twelve visitors were present.

The following officers were elected for the year 1927–28.

President: George Vaux, Jr.
Vice President: Wm. Clay
Secretary: F. A. Cajori
Treasurer and Councilor: H. W. Trudell

Dr. Witmer Stone, representing the Academy of Natural Sciences, congratulated the Society on attaining its thirty-fifth anniversary.

Mr. Vaux addressed the Society, his subject being, "1892–1927, A Retrospect and some Comments on the Future." The growth of mineralogy during the last thirty-five years was discussed and the speaker described the modern methods employed in mineral collecting, mineral study and museum display.

Mr. J. C. Boyle then addressed the Society on "Reminiscences." He recounted what, in his judgment, were the outstanding activities of the Society and its members during the last decade. The speaker showed a large number of interesting lantern slides of pictures taken on various collecting trips.

A number of early documents of the Society were turned over to the Society by Mr. Benge who had them in his possession.

The Society then adjourned to inspect the laboratories and mineral hall of the Academy where refreshments were served. A special feature was an exhibit of specimens by members, including a display of French Creek minerals.

F. A. Cajori, *Secretary*

NOTES AND NEWS

ANNUAL MEETING OF THE MINERALOGICAL SOCIETY OF AMERICA

The eighth annual meeting of The Mineralogical Society will be held December 29–31, 1927, at Western Reserve and Case School of Applied Science, Cleveland, Ohio. The first session of the Mineralogical Society will be held at 2 p.m. on Thursday, December 29, in the Geology Lecture Room at Case.

It is earnestly requested that *everyone* secure a *certificate* when purchasing a ticket to Cleveland for if 250 or more certificates are presented by those attending the combined meetings a half fare return rate will be granted. Even those not intending to use the certificates for their return trip are urged to comply with this request in order that the required number may be secured.

A *preliminary* list of titles of papers to be presented at the annual meeting will be found on the last page of this issue. Other notices will be found on cover 3.

Frank R. Van Horn, *Secretary*

Dr. W. F. Foshag, of the division of mineralogy, U. S. National Museum, spent four months in the mining districts of Mexico, particularly in the States of Zacatecas, Chihuahua, Durango and Sonora. About thirty-five boxes of specimens have been collected and sent to the Museum.

Dr. William A. P. Graham, instructor in geology at the University of Iowa, has accepted an associate professorship of geology at Texas Technological College.

Mr. J. Frank Schairer, graduate student at Yale, has been appointed to the staff of the Geophysical Laboratory at Washington, D. C.

Mr. George Vaux, Jr., of Bryn Mawr, Pa., president of the Mineralogical Society of Philadelphia and former vice-president and member of the Council of The Mineralogical Society of America, died Oct. 24. A memorial sketch of his life will appear in a later issue of the Journal.

CORRECTIONS TO VOLUME 12.

No. 1, p. 14, 11th line from bottom, for “fancaise” read “francaise”.
p. 17, 16th line, for “hydrargyllite” read “hydrargillite”.
p. 18, 11th line, for “alumnium” read “aluminum”.
p. 19, 17th line, for “erythrocalcite” read “eriochalcite” (cf. p. 263).
p. 28, 19th line, for “eithty” read “eighty”. Bottom line for “Natururssenschaften” read “Naturwissenschaften”.
No. 3, p. 96, lines 3, 4, 12 and 14 for “olivene” read “olivine.”
p. 97, 2nd line from bottom, for “epidoto” read “epidote.”
No. 4, p. 110, for numbers in first column, last two lines, for “33 and 89” read “38 and 39.”
plate 111, facing p. 125, interchange legends and numbers for figures 15 and 16.
p. 131, last column, 7th line from top, for “13” read “3.”
p. 176, figure 2, the line between the brachydomes *f* and *x*, and also the letter *f*, are omitted. See figure 4.
p. 184, figure 2, the line between *c* and *r* should be horizontal.
p. 185, 12th line, for “figure 5” read “figure 6.”
p. 186, 2nd line, for “6” read “5.”
No. 5, page references on cover should all be increased by 1.
p. 213, legend of cut, for “Lyndoch” read “Lyndochite.”
p. 221, 5th and 18th lines, for “231” read “232.”
p. 225, 15th line from bottom, for “nucleas” read “nuclear.”
No. 7, p. 278, 2nd line from bottom, for “Doleter” read “Doelter.”
p. 289, 6th line, for “Blass” read “Blaas.”
p. 291, 11th line, for “Ridgeway” read “Ridgway.”
No. 8, p. 313, 13th line, for “Mannebach” read “Manebach.”
p. 322, 12th line from bottom, for “pharcolite” read “phacolite.”
No. 9, p. 331, 16th line from bottom, for “Federoff” read “Fedoroff.”
p. 340, 22nd line, for “spessartite” read “grossularite.”
p. 348, 19th line, for “relationsip” read “relationship.”
p. 349, 18th line from bottom, for “Oxydes” read “Oxides.”
No. 10, p. 365, 10th line, for “pegmantite” read “pegmatite”.
p. 382, 5th line from bottom, for “Kostylena” read “Kostuileva.”
No. 11, p. 390, 17th line, for “Microcystalline” read “Microcrystalline.”
p. 396, 1st line, for “Kingden” read “Kingdon.”
p. 396, 9th line from bottom, transpose “and a later period of” to 5th line from bottom, inserting before “deposition.”
p. 397, 14th line from bottom, for “flurite” read “fluorite.”
p. 399, 2nd line, for “olivene” read “olivine.” The same misprint occurs frequently on pages 399, 400 and 402.

In addition to the above the following should be noted: Volume **10** (1925), page 147, line 5, for “$Na_4Ca_2Al_7Si_{13}O_{40}$” read “$Na_5CaAl_7Si_{13}O_{40}$.” The same correction applies to page 170, line 22, of the same volume.

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Prepared by L. S. Ramsdell

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